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Biology and utilization of anadromous alosids: Annual progress report (October 1, 1968 - September 30, 1969

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ANNUAL PROGRESS REPORT

ANADROMOUS FISH PROJECT

Project Title: Biology and Utilization of Anadromous Alosids

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ABSTRACT

Estimates of average annual mortality rates were derived from the decline in numbers of repeat river herring spawners each year in the Rappahannock and Potomac Rivers. The 1961 year-class contributed slightly more than 6 million fish to the fishery since 1965 while the 1962 year-class contributed nearly 5 million fish. Estimates could not be made for the James and York Rivers because the catch could not be measured. Fishing effort generally declined from 1968 in all major rivers with the Potomac River exhibiting the greatest decline. The catch of river herring in 1969 was generally lower than in 1968. Shad catches exhibited a similar trend except in the Rappahannock River where the catch increased somewhat.

Seaward migration of juvenile alosids was complete in the Potomac River by late November and in the Rappahannock River by mid-December.

The spawning area in the James River is the mainstream and its tributaries between JA 40 and JA 70. The nursery lies between JA 30 and JA 84. The greatest concentration of juveniles was found between JA 60 and Turkey Island Oxbow. Flooding caused by Hurricane Camille during August displaced juvenile alosids some 20 to 30 miles downstream.

PHASE 1

MORTALITY RATES

Catch curves have been plotted for the river herring fisheries in the Rappahannock River (Figs. 1-3) and the Potomac River (Figs. 4-7). Average annual total mortality rates estimated from the descending portion of the curves range from a low of 42% to a high of 74% (Table 1). These estimates are derived from the decline in numbers of repeat spawners in each year. This technique assumes that recruitment is constant from year to year, an assumption which is obviously not true (Figs. 1, 3, 5, 7). A better technique is to follow a single group of fish through the fishery for a series of years. At this time our data allow us to do this for only two groups of alewife in the Potomac River (Fig. 8). The group of alewife which spawned for the first time in 1965 (mostly fish of the 1961 year-class) contributed an estimated 6,048,000 fish to the fishery during the four years in which it appeared in the catch. The group spawning for the first time in 1966 contributed an estimated 4,743,000.

We are unable to estimate mortality rates in the James River and in the York River because we have no way of estimating the week-to-week fluctuations in the magnitude and composition of the runs in those two rivers. Estimates of these features are

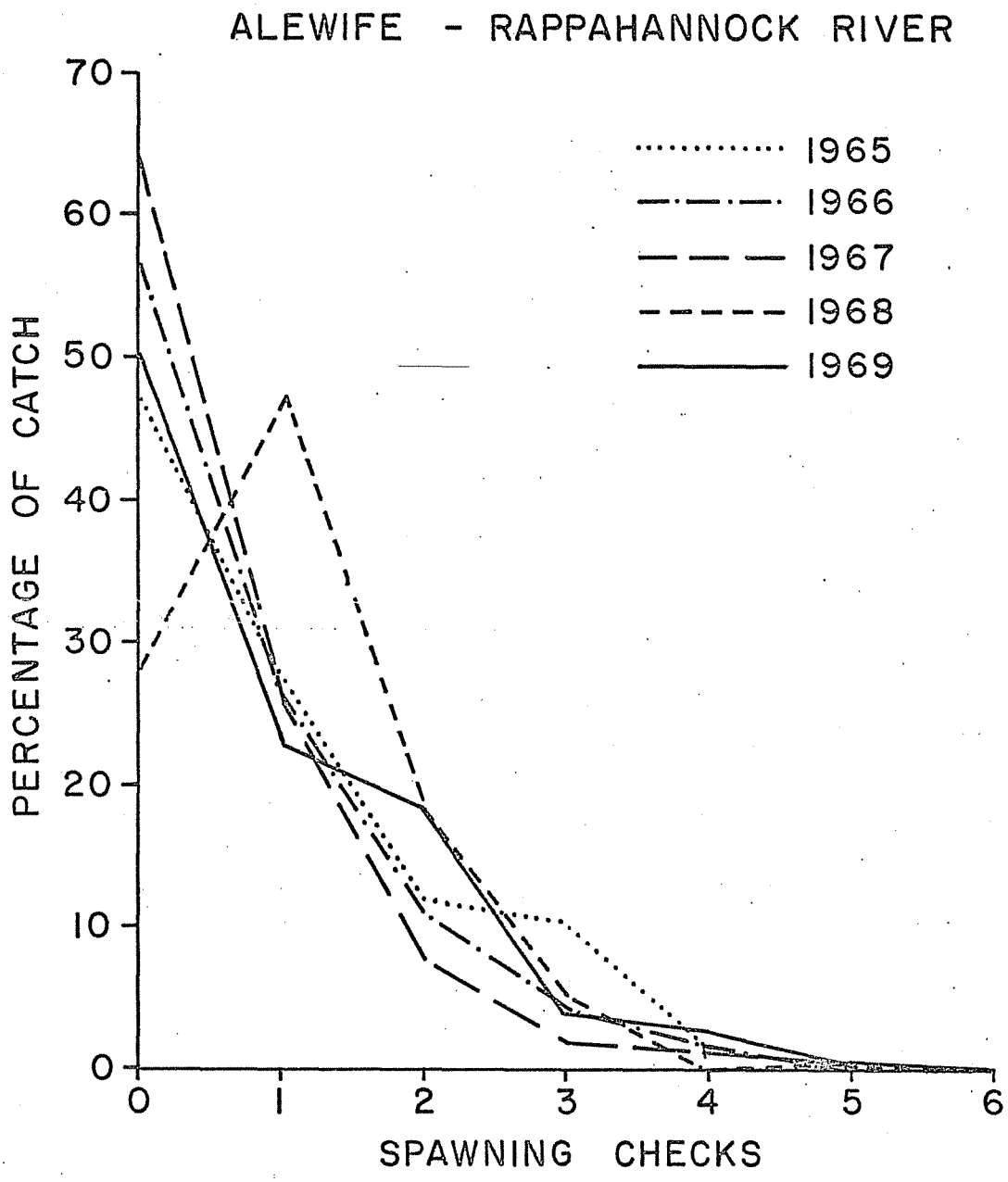

Fig. 1. Catch curves of alewife in the Rappahannock River.

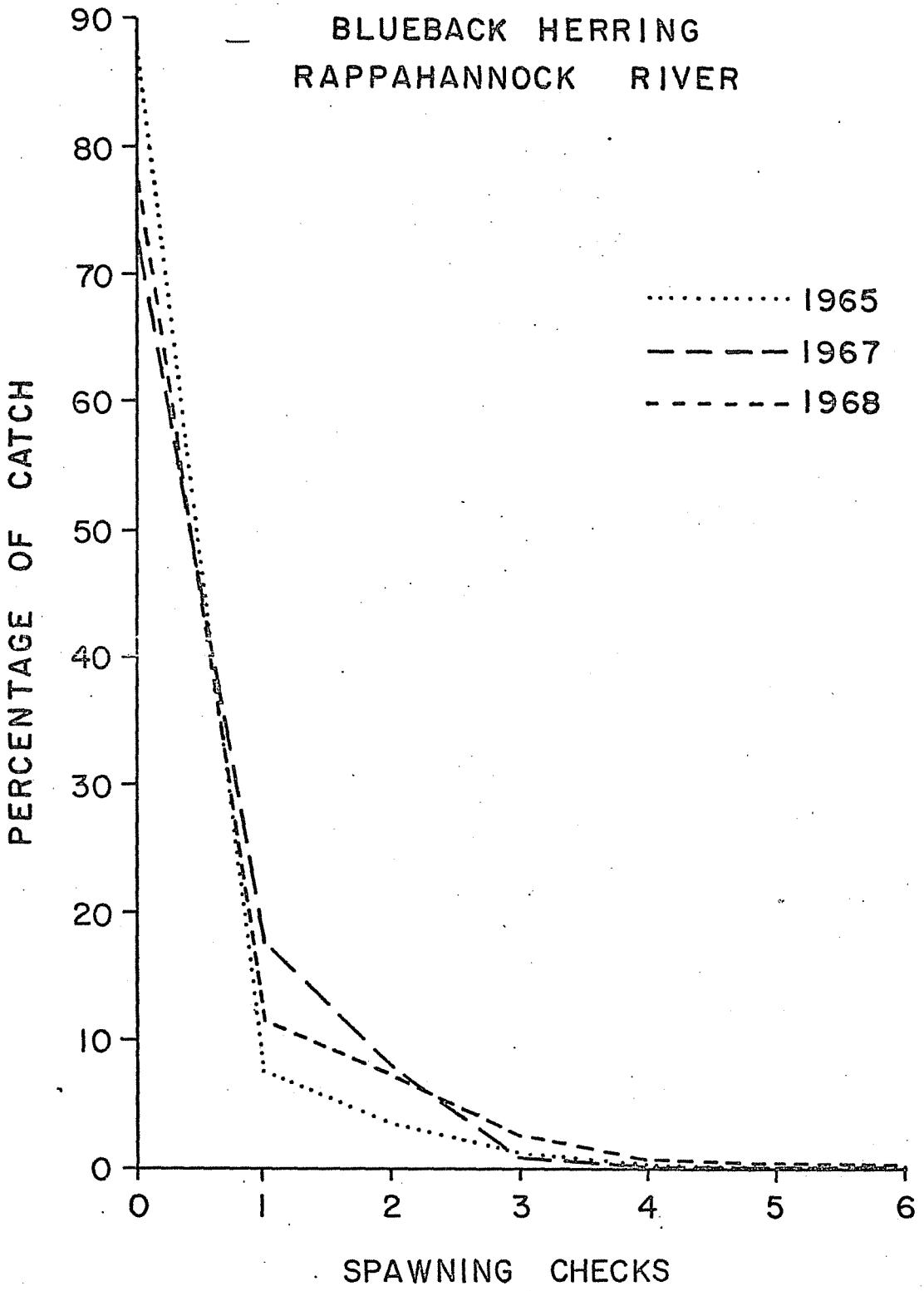

Fig. 2. Catch curves of blueback herring in the Rappahannock River.

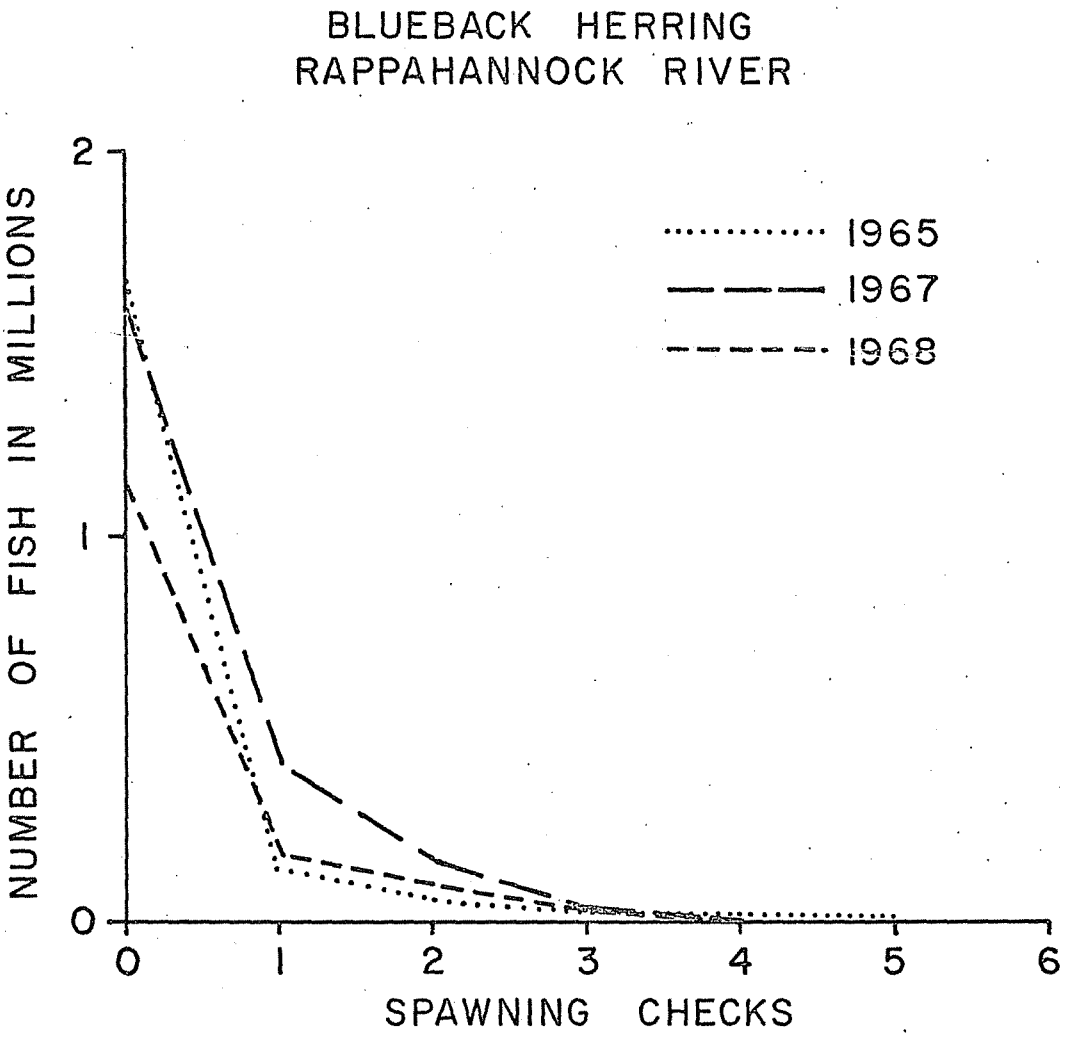

Fig. 3. Estimated number of blueback herring caught in the Rappahannock River

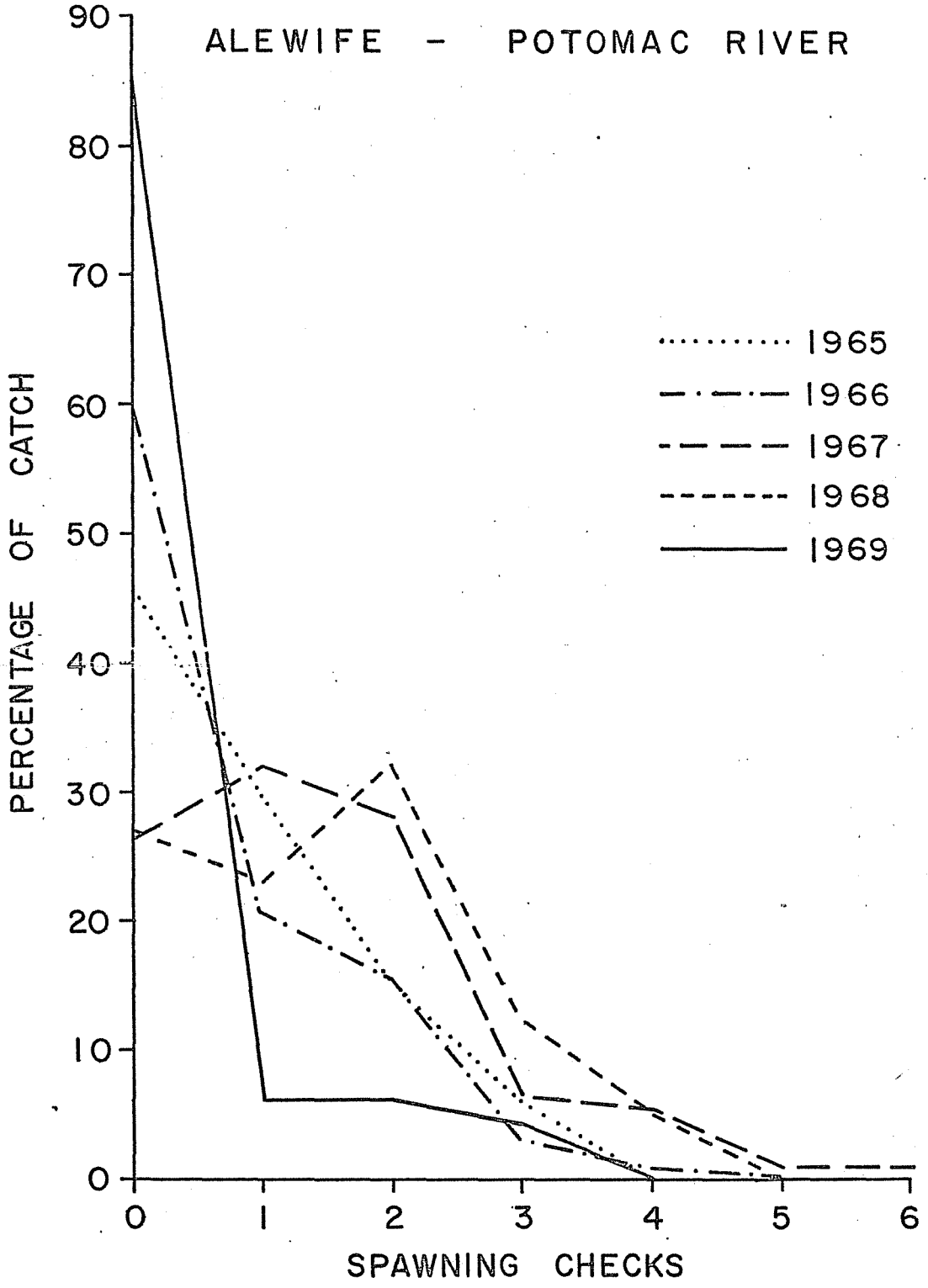

Fig. 4. Catch curve of alewife in the Potomac River.

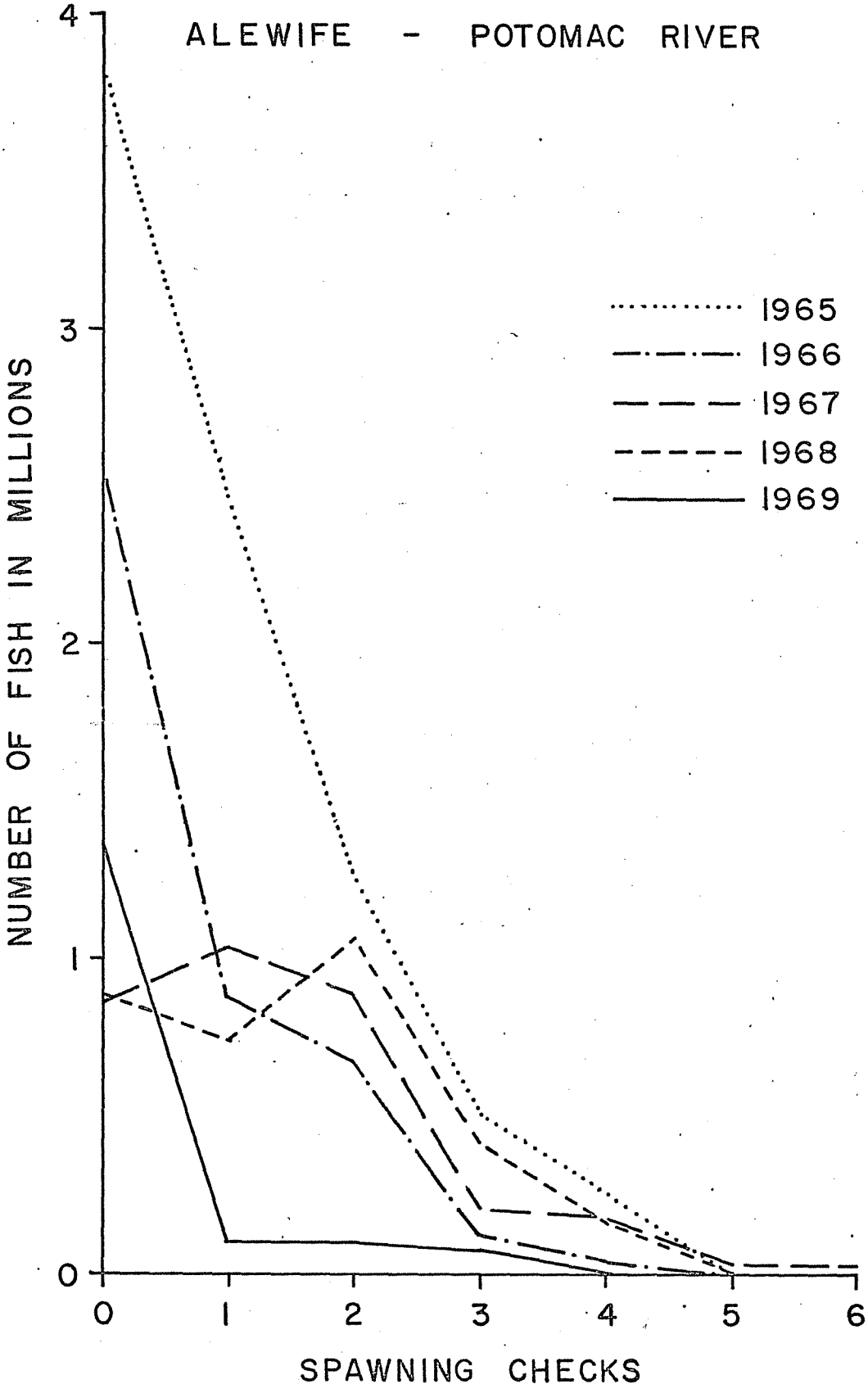

Fig. 5. Estimated numbers of alewife caught in the Potomac River in each of several years.

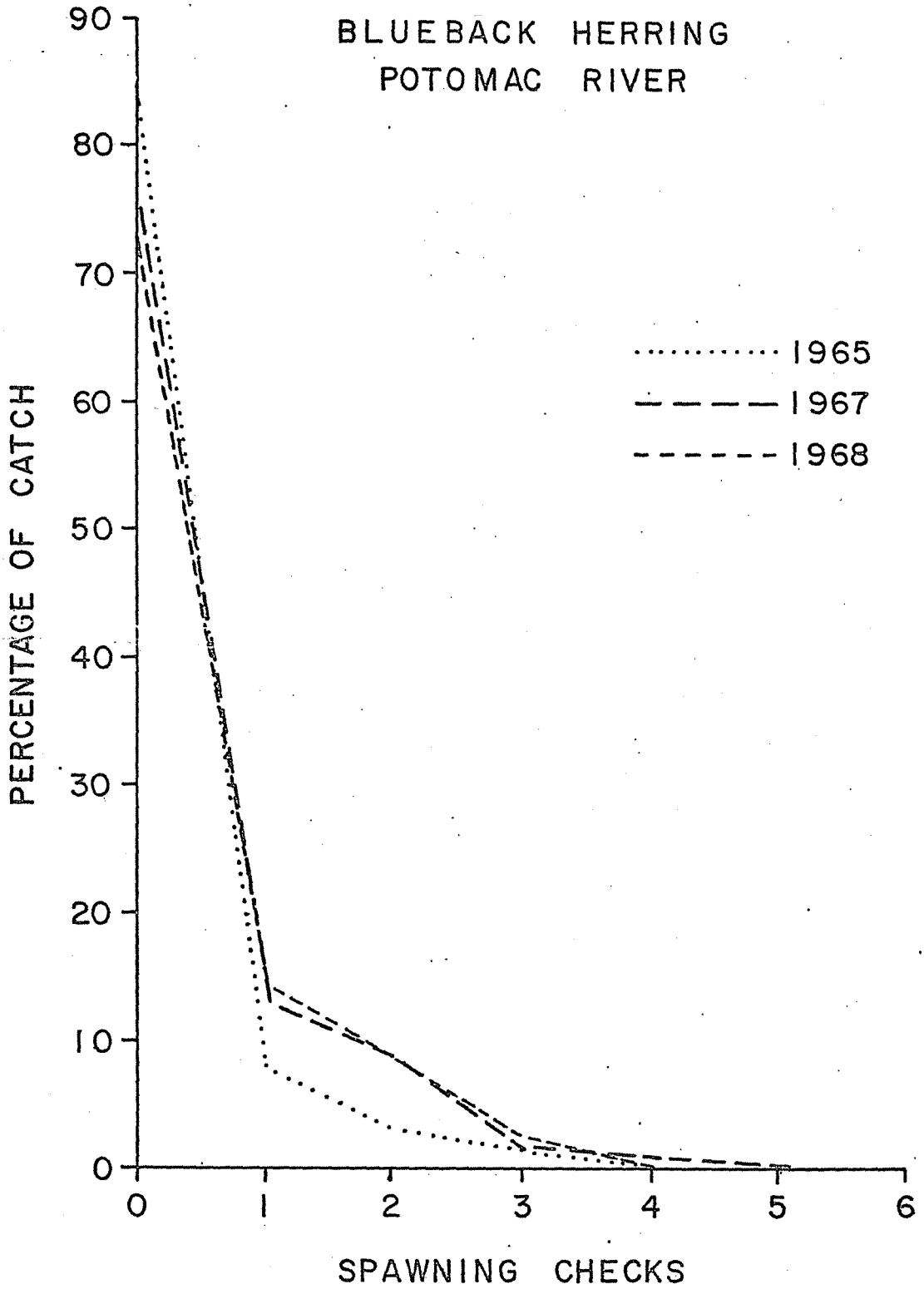

Fig. 6. Catch curve of blueback herring in the Potomac River.

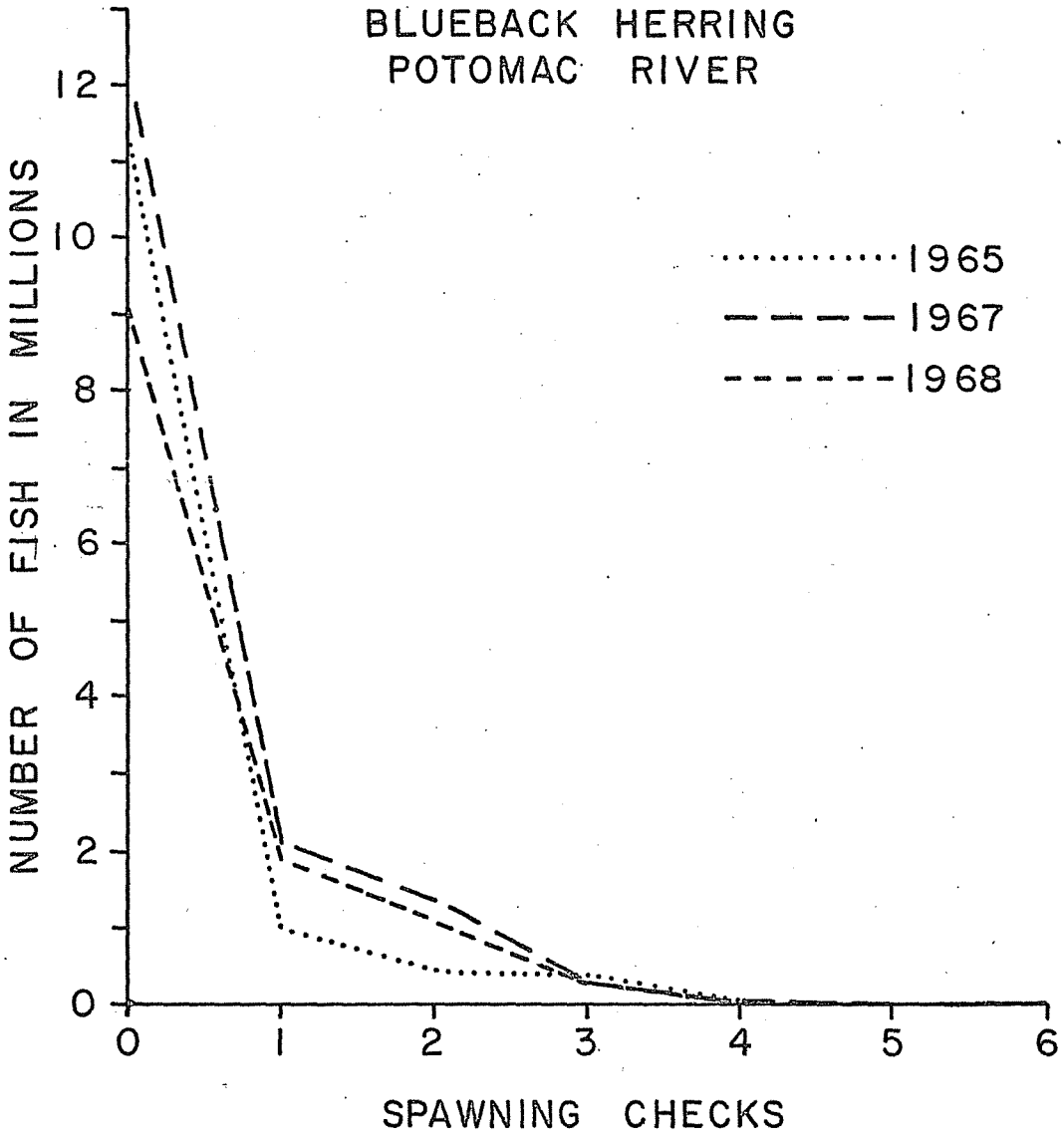

Fig. 7. Estimated number of blueback herring caught in the Potomac River in each of several years.

Table 1. Estimated total annual mortality rates of alewife and blueback herring in the Rappahannock River and Potomac River.

	Alewife		Blueback	
	Rappahannock	Potomac	Rappahannock	Potomac
1965	52	48	70	72
1966	58	60	*	*
1967	66	47	74	64
1968	72	60	67	94
1969	54	42	*	*

* Scales not yet examined.

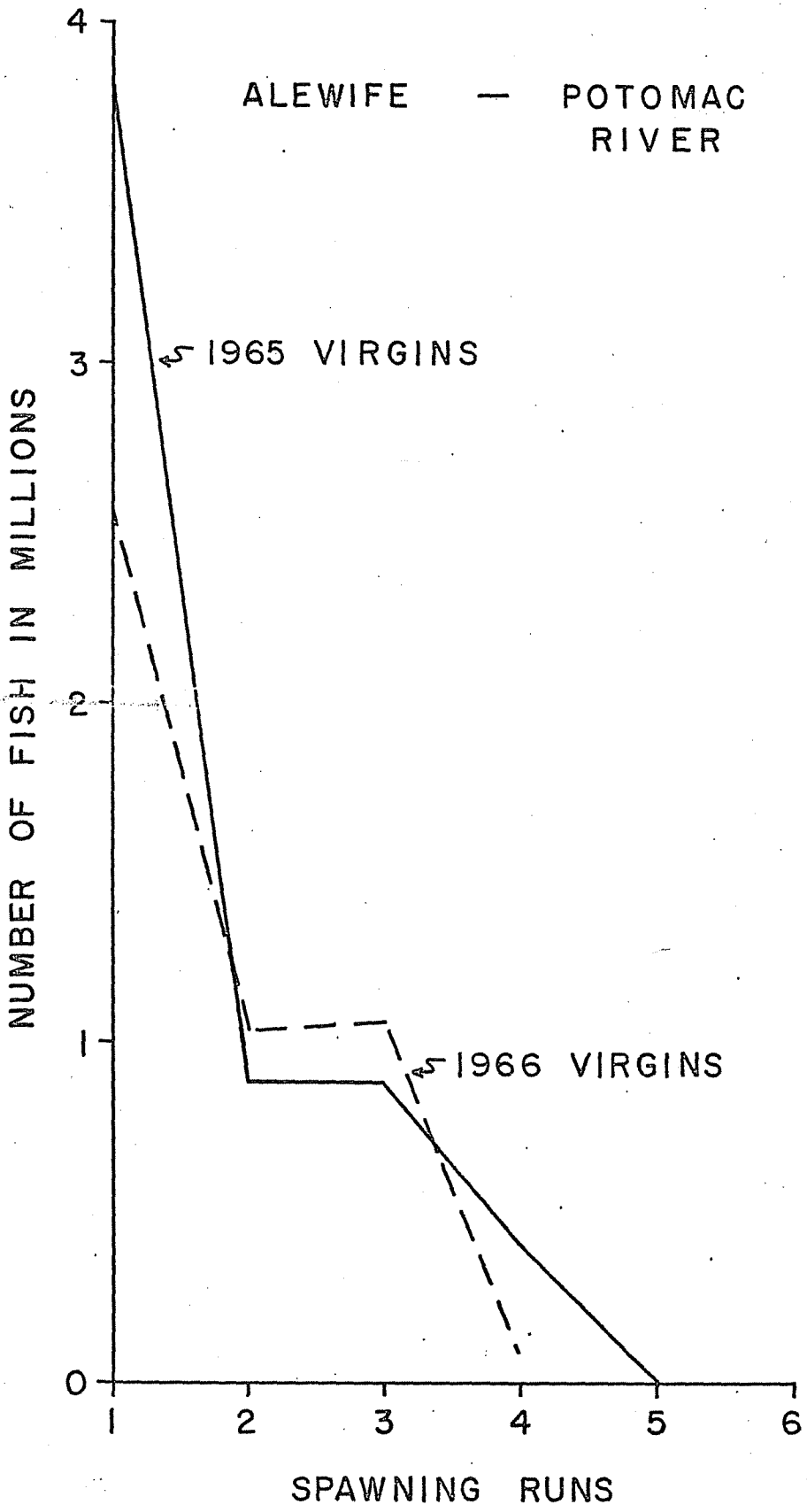

Fig. 8. Estimated number of alewife caught from two spawning classes in the Potomac River.

obtained from records of pound net catches in the Potomac River and Rappahannock River, but comparable records were unobtainable from the other two rivers. The few pound nets in the James were apparently poorly positioned and caught very few fish. All nets in the York were within three miles of the mouth. Presumably nets so near the river mouth catch some fish which would have spawned in a different river, but strayed into the York. Furthermore catches from nets in the York River usually were mixed with catches from nets in Chesapeake Bay before being landed. Consequently, samples representative of the York River population were not available.

PHASE 2

CATCH PER UNIT OF EFFORT

The number of pound nets operating (Table 2) declined somewhat from the previous year. The decline was general over the entire area and was most pronounced in the Potomac River.

The preliminary estimate of the catch of river herring in 1969 is 30,445,828 pounds (U.S. Fish and Wildlife Service C.F.S. No. 5241), only about 2 million pounds less than in 1968. However, the catch in the Potomac River reportedly declined from 7.5 million pounds in 1968 to 3.4 million pounds in 1969. In view of the fact that the Potomac River usually contributes between 25% and 30% of the total catch, it seems likely that the preliminary estimate of 30.4 million pounds will be revised downward. Our sources of information indicate that poor fishing was not limited to the Potomac in 1969, but that fishermen throughout the area experienced lighter catches. Since the available estimate of the catch is seemingly in error, we have not calculated catch per unit of effort in the 1969 season but will do so when a revised estimate becomes available.

Pound nets in the Rappahannock River above RA 10 caught an estimated 1.2 million pounds of river herring (842,562 pounds of alewife and 374,482 pounds of blueback herring) and about 263,000

Table 2. Numbers of pound nets in Chesapeake Bay and tributaries, spring 1969.

Area	2-24-69	3-6-69	3-26-69	4-8-69	4-24-69	5-8-69	5-27-69	6-19-69
James River	0	1	2	2	2	2	3	4
York River	3	5	8	8	8	9	10	10
Rappahannock River	7	25	44	53	52	37	18	4
Potomac River	2	7	22	38	67	69	58	7
Cape Henry to Willoughby Point	3	4	8	8	9	8	5	8
Old Point to Tue Marsh Point	0	7	13	16	17	15	11	3
Back River	2	5	7	5	7	6	4	0
Poquoson River	2	2	3	3	3	2	2	3
York Spit	1	1	4	8	11	12	10	8
Mobjack Bay	0	0	7	7	7	8	6	5
New Point to Stingray Point	3	8	27	27	27	27	12	11
Piankatank River	0	0	3	3	4	4	2	0
Windmill Point to Smith Point	9	20	38	45	48	49	37	10
Great Wicomico River	1	1	1	1	1	3	3	2
Eastern Shore-N. Hungar Creek	NO*	NO*	0	1	3	3	3	0
Eastern Shore-S. Hungar Creek	NO*	NO*	0	5	19	24	24	21
Totals	33	86	187	230	285	278	208	96

* Not Observed

pounds of shad in the period March 12 - May 10 (Table 3). In a comparable period in 1968 the catch of river herring and shad was somewhat greater. The catch of alewife in 1969 was 68% of that in 1968, the blueback catch was 92% and shad 87%.

The catch of shad in the Rappahannock River by stake gill nets during the period March 10 - April 30 was estimated at 193,122 pounds, of which only 32,273 pounds was males (Table 4). Since pound nets, which probably are not selective for size, caught a greater quantity of males than females, the opposite trend in the gill net landings probably results from escapement of the smaller males and from lack of market for males. Total catch of shad in the Rappahannock River by both pound nets and stake gill nets was estimated at 456,000 pounds. Stake gill nets took an estimated 44,000 pounds of hickory shad, probably mostly females. Bucks, having no market are usually discarded at the net. The estimated catch of hickory shad in 1969 was about twice that in 1968.

In the York River stake gill nets caught an estimated 174,349 pounds of shad and 1,459 pounds of hickory shad (Table 5). The catch of buck shad and hickory shad was undoubtedly greater than the landings. The market for these was so poor that fishermen discarded most of them at the net. In 1968 the catch of shad was 221,000 pounds. Pound nets in the York River were not suitably positioned to serve as indices of the run of river herring.

Stake gill nets in the James River took an estimated 1,569,000 pounds of shad between March 1 and April 30, 1969. Gear selectivity and market conditions are reflected by harvest of only 134,000

Table 3 . Catch by pound nets in the Upper Rappahannock River, 1969*

Date	Ave. No. of Nets	No. Days Fished	SHAD						RIVER HERRING			
			Roe		Buck				Alewife		Blueback	
			Ave. Catch Index Nets	Estimated Total Catch	Ave. Catch Index Nets	Estimated Total Catch	Ave. Catch Index Nets	Estimated Total Catch	Per Cent	Pounds	Per Cent	Pounds
March 12-15	35	4	2.0	280	16.8	2,352	1,519	212,660	100	212,660	0	0
March 16-31	48	12	21.6	12,442	50.9	29,318	671	386,496	100	386,496	0	0
April 1-15	53	13	95.1	65,524	151.3	104,246	522	359,658	44	158,250	56	201,408
April 16-31	45	7	33.9	10,679	79.0	24,885	680	214,200	34	72,828	66	141,372
May 1-10	37	7	17.5	4,533	33.3	8,625	170	44,030	28	12,328	72	31,702
Totals				93,458		169,426		1,217,044		842,562		374,482

*Only nets between RA10 and RA55 were sampled to represent fish assumed to spawn in the Rappahannock River System.

Estimated Total Catch of Shad - 262,884.

Table 4. Catch by stake gill nets in the Rappahannock River, 1969

		Roe Shad	Buck Shad	Hickory Shad
March	10	56	154	-
	11	115	132	-
	12	-	-	-
	13	166	306	-
	14	-	-	-
	15	172	316	-
	16	-	-	-
	17	527	667	-
	18	-	-	-
	19	725	782	-
	20	119	111	-
	21	1,392	998	-
	22	400	458	6
	23	-	-	-
	24	913	530	-
	25	536	511	-
	26	1,761	1,383	-
	27	1,617	692	31
	28	1,685	1,193	13
	29	1,913	1,086	197
	30	1,581	1,053	-
	31	4,169	1,336	140
April	1	3,311	729	620
	2	7,424	2,574	862
	3	5,881	1,782	653
	4	6,351	1,544	1,223
	5	6,279	1,862	72
	6	-	-	-
	7	16,520	2,418	1,346
	8	10,335	671	1,472
	9	7,983	1,535	1,642
	10	10,518	1,141	794
	11	8,009	1,217	4,265
	12	12,562	899	3,069
	13	3,613	519	3,011
	14	10,214	523	4,019
	15	6,351	1,014	3,159
	16	5,626	320	2,997
	17	4,253	443	2,783
	18	5,173	476	2,997
	19	3,563	170	1,798
	20	-	-	-
	21	4,779	269	3,143
	22	1,328	-	879
	23	735	-	1,295
	24	905	103	1,096
	25	887	111	587
	26	201	98	197

Table 4. continued

		Roe Shad	Buck Shad	Hickory Shad
April	27	-	-	-
	28	201	90	133
	29	-	-	78
	30	-	57	43
Totals		160,849	32,273	44,620

Table 5. Catch by stake gill nets in the York River, 1969

		Roe Shad	Buck Shad	Hickory Shad
March	10	33	-	-
	11	-	66	-
	12	-	-	-
	13	24	54	-
	14	-	-	-
	15	-	-	-
	16	-	-	-
	17	-	-	-
	18	77	121	-
	19	75	70	-
	20	236	232	-
	21	-	-	-
	22	-	-	-
	23	600	333	-
	24	1,600	1,066	-
	25	4,666	2,266	-
	26	3,866	799	-
	27	3,732	533	132
	28	533	-	132
	29	10,133	-	-
	30	-	-	-
	31	18,000	-	-
April	1	7,067	-	266
	2	7,466	-	399
	3	13,599	-	266
	4	666	-	132
	5	18,532	-	-
	6	-	-	-
	7	23,066	-	-
	8	6,133	-	-
	9	5,999	-	132
	10	6,666	-	-
	11	-	-	-
	12	16,400	-	-
	13	-	-	-
	14	8,133	-	-
	15	2,399	-	-
	16	2,533	-	-
	17	3,147	-	-
	18	-	-	-
	19	1,600	-	-
	20	-	-	-

Table 5. continued

	Roe Shad	Buck Shad	Hickory Shad
April 21	630	-	-
22	533	-	-
23	266	-	-
24	399	-	-
Totals	168,809	5,540	1,459

pounds of bucks. The fishermen from whom we obtained records reported no hickory shad (Table 6). We were unsuccessful in obtaining records from the James in 1968 and therefore, can not compare catches in the two years. Fishermen felt that 1969 was a reasonably good year for shad.

The few pound nets fished in the James River caught too few river herring and shad to be useful in sampling the run.

In the Potomac River the catch of river herring has declined rather drastically from 8.4 million pounds in 1967 to 7.6 in 1968, to 3.4 in 1969 (Tables 7, 8, 9). The decline has been of greater proportions in the blueback herring catch than in the alewife catch. The catch of shad in the Potomac River has fluctuated independently of the trend in river herring. The decline in river herring is attributable to a combination of factors including harvest on the high seas by foreign vessels, mostly Russian, Latvian, Lithuanian, and Estonian, and to poor reproductive success of alewife in 1963 and 1964 (Fig. 5). Year-classes 1963 and 1964 spawned for the first time in 1967 and 1968. Cause of the apparent reproductive failure is unknown at this time.

Table 6. Catch by stake gill nets in the James River, 1969

		Roe Shad	Buck Shad	Hickory Shad
March	1	-	460	-
	2	-	-	-
	3	-	1,500	-
	4	-	-	-
	5	-	1,500	-
	6	-	-	-
	7	-	-	-
	8	-	1,500	-
	9	-	-	-
	10	-	-	-
	11	-	-	-
	12	-	-	-
	13	403	8,740	-
	14	-	-	-
	15	-	750	-
	16	-	-	-
	17	-	1,500	-
	18	-	-	-
	19	382	958	-
	20	-	-	-
	21	2,369	6,647	-
	22	-	-	-
	23	3,588	9,246	-
	24	3,979	4,991	-
	25	8,234	14,237	-
	26	9,131	16,675	-
	27	16,077	24,058	-
	28	30,130	34,500	-
	29	13,340	-	-
	30	68,517	-	-
	31	68,954	-	-
April	1	71,576	-	-
	2	57,500	-	-
	3	61,813	-	-
	4	80,017	-	-
	5	50,094	-	-
	6	47,150	-	-
	7	-	-	-
	8	67,597	7,222	-
	9	80,500	-	-
	10	56,465	-	-
	11	62,376	-	-
	12	49,933	-	-
	13	-	-	-
	14	52,992	-	-

Table 6. continued

	Roe Shad	Buck Shad	Hickory Shad
April 15	41,400	-	-
16	35,673	-	-
17	38,928	-	-
18	60,904	-	-
19	64,745	-	-
20	-	-	-
21	36,616	-	-
22	38,939	-	-
23	28,543	-	-
24	16,767	-	-
25	-	-	-
26	38,364	-	-
27	30,222	-	-
28	21,459	-	-
29	-	-	-
30	19,251	-	-
Totals	1,434,928	134,484	-

Table 7. Total Alosa catch by month in Potomac River in 1967

	Roe Shad	Buck Shad	Herring	
			Alewife	Blueback
March	1,318	4,127	41,425	41,426
April	103,595	59,093	753,278	925,118
May	24,351	8,622	563,852	5,074,677
June	825	9,620	-	1,001,291
Totals	130,089	81,462	1,358,555	7,042,512
		211,551		8,401,067

Table 9. Total Alosa catch by month in Potomac River in 1969

	Roe Shad	Buck Shad	Herring	
			Alewife	Blueback
March	611	2,517	18,138	36,278
April	163,766	68,102	397,061	1,073,537
May	40,061	22,761	169,452	1,713,357
June	375	18	-	15,104
Totals	204,813	93,398	584,651	2,838,276
	298,211		3,422,927	

PHASE 3

LOCATION OF SPAWNING SITES AND NURSERIES

The objective of Phase 3 of the program this contract period was to locate spawning and nursery areas of anadromous alosids in the James River system and to continue our work in the Rappahannock and Potomac River systems. Figure 9 illustrates the nursery areas of river herring and shad in the four larger tributaries to lower Chesapeake Bay.

Rappahannock and Potomac Rivers

Field work continued in the Potomac and Rappahannock Rivers until November of 1968 and January of 1969 respectively, in order to follow the seaward movement of juvenile alosids. Nearly all juvenile alosids left the nursery areas of both river systems by mid-November (Tables 10 and 11), this seaward migration being correlated with decreasing water temperatures (Figures 10 and 11). Trawl stations were occupied through January 1969 in the Rappahannock River to monitor movements of juvenile alosids. We did not continue sampling the Potomac River into the winter, but presumed that the distribution of juvenile alosids in the lower Rappahannock River would reflect their distribution in the Potomac River also since the general distribution regime in the two rivers was similar throughout the year.

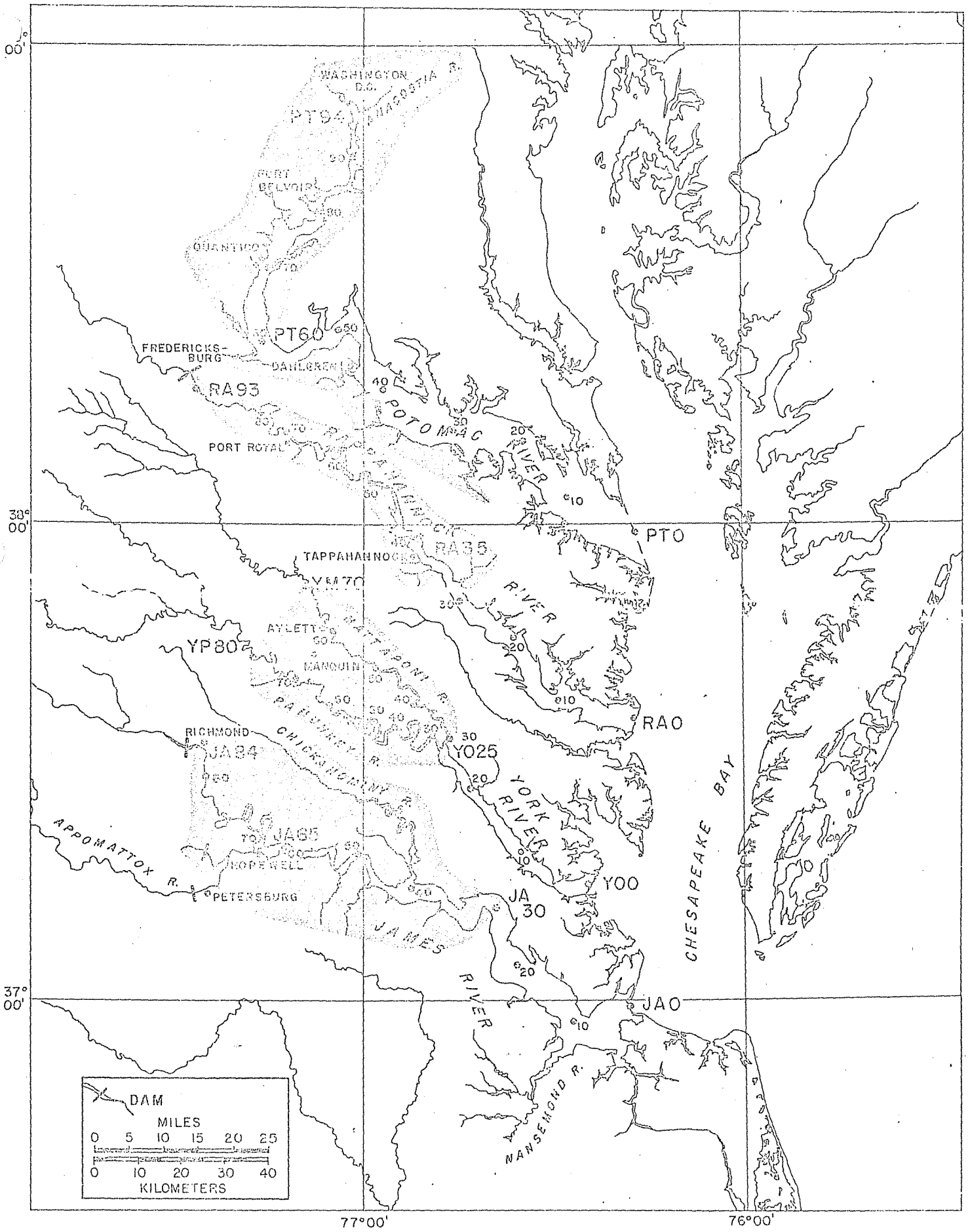

Fig. 9. Nursery Areas of River Herring and Shad

Table 10. Monthly Distribution of all Alosids in the Rappahannock River

		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	Total
June	S	-	-	-	-	-	-	-	9	31	45	43	178	208	149	89	214	-	-	-	966
July	S	-	-	-	-	-	X	X	X	5	12	71	292	1064	180	132	311	111	118	70	2366
	B	-	-	X	X	X	X	X	2	16	X	1	X	2	25	2	33	148	20	3	252
August	S	-	-	-	-	-	X	1	8	X	X	2	42	94	62	24	96	97	69	27	522
	B	-	-	-	-	-	1	X	X	3	3	1	X	13	1	4	3	4	9	360	402
September	S	-	-	X	X	X	X	X	2	X	X	X	X	137	63	56	77	110	125	135	705
	B	-	-	X	X	X	X	X	X	1	X	1	1	2	X	X	X	24	29	1	59
October	S	X	X	-	X	X	X	X	1	4	X	X	X	15	54	44	X	X	2	8	125
	M	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	B	X	X	X	X	X	X	X	X	X	X	X	3	1	79	30	183	X	3	27	326
November	S	X	X	X	X	X	1	X	X	9	X	X	1	4	6	X	X	X	X	X	21
	M	X	X	X	X	X	11	X	14	-	-	-	7	1	-	-	-	-	-	-	33
	B	X	X	53	X	127	1	3	4	3	8	X	X	1	9	X	X	X	X	X	209
December	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	M	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	
	B	X	X	64	2	X	1	7	4	X	X	-	-	-	-	-	-	-	-	-	78
Totals				117	2	127	14	12	43	72	68	119	524	1538	628	381	917	494	375	631	

X Station sampled but no alosids caught
- Station not sampled

Table 11. Monthly distribution of all Alosids in the Potomac River

		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	94	96	Total
June	S	-	-	-	-	-	-	-	-	-	-	X	X	4	3	131	18	19	-	2	26	-	203
July	S	-	-	-	-	-	-	-	-	-	X	-	1	60	3810	-	1243	500	235	157	29	-	6035
	M	-	-	-	-	-	-	-	-	-	X	-	X	51	2664	-	109	136	61	7	X	-	3028
	B	-	-	-	-	-	-	-	-	-	X	X	1	1	30	-	3	4	X	X	X	-	39
August	S	-	-	X	X	X	X	X	X	X	X	X	X	3	1	53	58	327	447	16	8	-	913
	M	-	-	-	-	-	-	-	-	-	-	-	-	-	125	268	156	59	14	2	6	-	630
	B	-	-	X	X	X	-	-	-	-	X	X	X	5	X	X	52	5	X	-	-	-	62
September	S	-	-	X	X	X	X	X	X	-	X	X	X	X	X	120	4	161	2119	X	132	-	2536
	M	-	-	-	-	-	-	-	-	-	-	-	-	-	17	2	99	311	106	1	49	-	585
	B	-	-	X	X	X	-	-	-	-	X	X	X	3	5	X	3	2	5	X	36	3	57
October	S	-	-	X	-	X	X	X	X	5	6	X	25	728	1907	45	1069	1092	732	1	762	62	6434
	M	-	X	-	X	-	X	-	-	-	145	X	6	13	369	12	224	1321	1333	11	147	X	3581
	B	-	X	X	X	X	-	-	-	-	5	X	X	8	19	4	27	39	47	X	3	40	192
November	S	X	X	X	-	-	-	X	-	-	1	1	X	1	X	2	X	X	X	-	X	X	5
	M	X	15	1	X	1	X	-	-	4	2	10	X	X	X	X	X	2	X	X	-	-	35
	B	X	X	X	X	X	-	-	-	-	X	X	X	4	1	X	X	X	X	X	X	X	5
December	S																						
	M										NO TRAWLS MADE												
	B																						
Totals			15	1		1				9	156	11	33	881	8951	637	3065	3978	5099	197	1198	105	

X Station sampled but no alosids caught
- Station not sampled

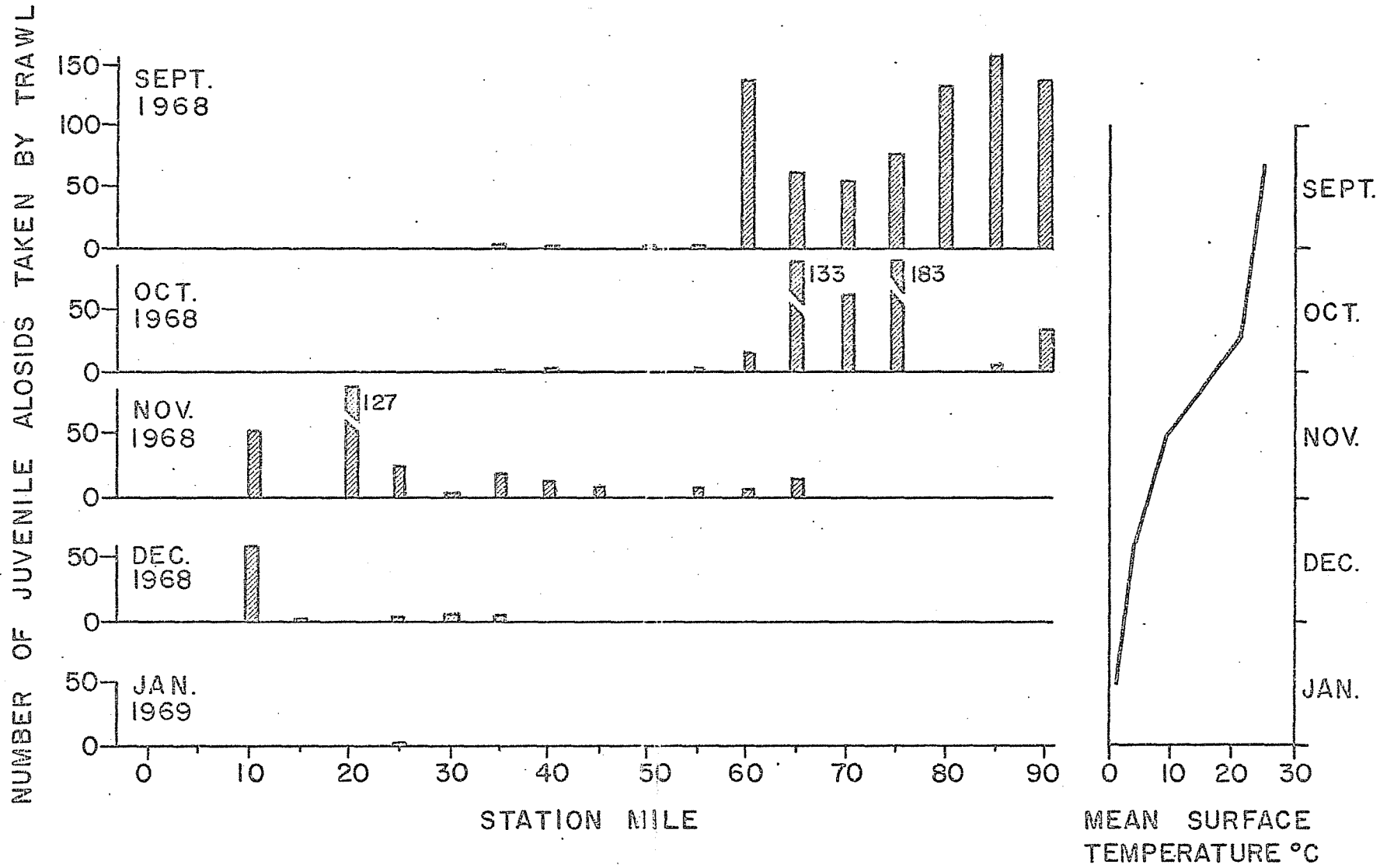

Fig. 10. Distribution of juvenile alosids in the Rappahannock River in relation to water temperature

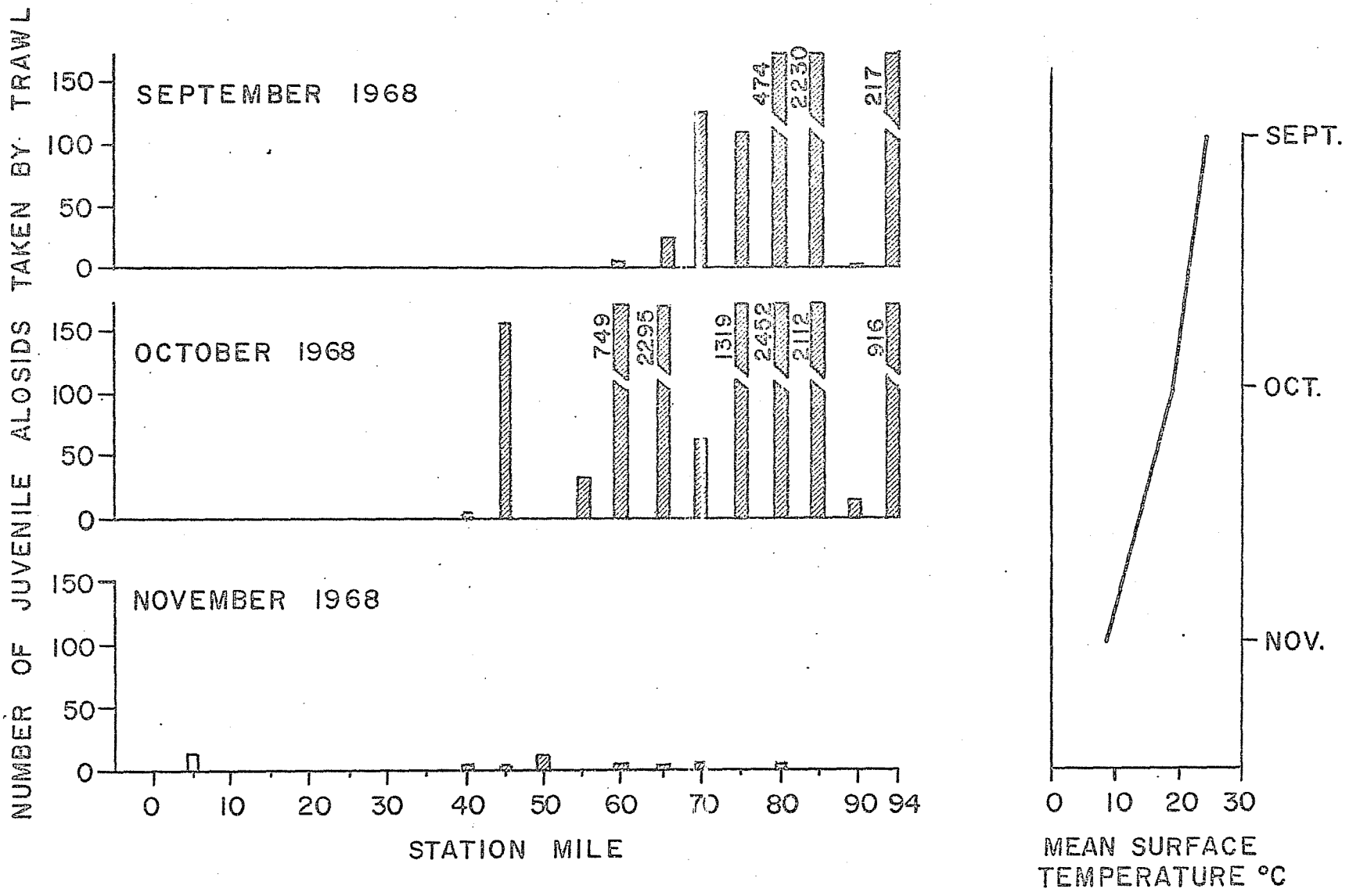

Fig. 11. Distribution of Juvenile Alosids In the Potomac River In Relation to Water Temperature

Table 10 shows monthly distribution of juveniles by river mile in the Rappahannock River with the exception of January 1969 when bottom trawls from RA 0 to RA 35 caught only one juvenile blueback at RA 25. From October 15 to November 13 average water temperature dropped from 20.7° C to 8.7° C and apparently initiated the seaward movement of juveniles. In November fewer fish were caught than in October and the population was centered in the lower river. In December trawls from RA 0 to RA 45 took only 78 fish, 64 of these from RA 10; average water temperature was down to 4° C and the seaward exodus of juveniles was mostly complete.

In the Potomac River the exodus of juvenile alosids was much more dramatic, particularly with reference to numbers of fish. From October 22 to 24, 49 trawls made between PT 0 and PT 94 captured 10,207 juvenile alosids; average water temperature was 19.7° C. During November 19 to 22, trawls made at almost the same locations as those in October netted only 42 juvenile alosids; average water temperature during November was 8.8° C. Migration of juvenile alosids from the Potomac River was virtually complete by the last of November.

Chesapeake Bay

To learn if any general route through Chesapeake Bay is preferred by the juvenile alosids on their seaward movement, 43 trawl tows were made at 21 stations in the Bay during November and December of 1968 and January of 1969. Stations were located from off the mouth of the Rappahannock River down to the Bridge-Tunnel. Though the number of stations and fish (total of 132) is

small; the stations in the mid-bay and near the western shore yielded more fish than did those near the eastern side.

James River

Spawning Areas

Efforts to locate spawning areas of alosids in the James River began on February 6 and continued through June 19. Spawning areas were identified by the presence of eggs or ripe adult fish. Adults, eggs, and larvae were collected from the main stream and tributaries. Adults were caught with gill nets. Drift nets were used principally at main stream stations, whereas anchored nets were used in the tributaries and shallow areas of the main stream. Eggs and larvae were collected in plankton nets. Few eggs were collected since river herring eggs, being adhesive, have a short planktonic existence. Gill nets and plankton nets were fished at mainstream stations and in tributaries from the mouth upstream to Upper Municipal Terminal in Richmond, JA 84 (designation for station in James River 84 miles from the mouth). Fishing effort amounted to 283 gill net sets capturing a total of 638 alosids over a period of 49 fishing days. The catch was 76% alewife, 13% American shad, 10% bluebacks, and 1% hickory shad. This is not considered indicative of the ratios of the species in the population, particularly the river herring, since gear selectivity favors the capture of alewife. Indeed the catch of juvenile herring indicates a predominance of bluebacks.

Alewife were captured at mainstream and tributary stations from JA 35 to JA 85 (Table 12). The greatest numbers of alewives per unit effort were taken from tributaries emptying into the James

Table 12. Spawning areas, James River system.

Mile	Mainstream or Tributary	Gravid or Ripe Fish			
		Alewife	Blueback	Am. Shad	Hickory
JA07	Chuckatuck Creek		X		
JA14	Cypress Creek		X		
JA35	Grays Creek	X			
JA35	Back River	X			
JA40	MS			X	X
JA40	Chickahominy	X	X		
JC02	Gordon Creek	X	X		
JC05	Blackstump Creek	X	X		
JC06	Yarmouth Creek	X			
JC07	Shipyard Creek	X			
JC08	Uncles Neck Creek	X			
JC09	Hog Neck Creek	X	X		
JC13	Diascund Creek	X	X		
	Edwards Swamp	X			
JC18	Barrows Creek		X		
JC07	Parsons Creek	X			
JC03	Morris Creek	X	X		
JA40	Tomahund Creek	X			
JA43	Sunken Marsh Creek	X			
JA45	Upper Chippokes	X	X		
JA49	Kennon Creek	X			
JA50	MS	X		X	
JA50	Tyler Creek	X			

Table 12. Spawning areas, James River system (cont.)

Mile	Mainstream or Tributary	Gravid or Ripe Fish			
		Alewife	Blueback	Am. Shad	Hickory
JA50	Mapsico Creek	X			
JA53	Weyanoke Point Creek	X			
JA53	Wards Creek	X	X		
JA54	Flowerdew Hundred Creek	X			
JA55	MS			X	
JA56	Queens Creek	X	X		
JA56	Gunns Run	X	X		
JA58	Herring Creek	X	X		X
JA59	Powell Creek	X	X		
JA60	MS			X	X
JA63	Eppes Creek	X	X		
JA65	MS	X			
JA66	Appomattox River	X		X	
JX01	Johnson Creek	X			
JX02	Railroad Creek	X			
JX04	Ashton Creek	X			
JX05	Swift Creek	X	X		
JX02	Cabin Creek	X			
JX02	Bull Hill Run	X			
JA67	Turkey Island Oxbow	X		X	
JA67	Turkey Island Creek	X			
JA67	Curles Swamp Creek	X			
170	MS	X	X	X	
JA71	Fourmile Creek	X			

Table 12. Spawning areas, James River system (cont.)

		Gravid or Ripe Fish			
Mile	Mainstream or Tributary	Alewife	Blueback	Am. Shad	Hickory
JA73	Farrar Island Oxbow	X		X	
JA73	Hatcher Island Oxbow	X			
JA74	Proctors Creek	X			
JA75	MS	X			
JA77	Cornelius Creek	X			
JA79	Falling Creek	X			
JA80	MS		X		
JA83	Almond Creek	X	X		
A85	MS	X	X		

River between JA 60 and JA 70.

The first adult alewife, a gravid male, was taken on February 6, the first day of field work, in the Chickahominy River with water temperature at 4.9° C. A gravid female was caught a few days later at approximately the same location. Spawning occurred from mid-March until mid-May. Water temperatures during this period ranged from 10.6 to 23.3° C. The peak of spawning appeared to be in late April since more spent and partially spent fish were taken during this period.

Bluebacks entered the river later than alewives and were found at mainstream and tributary stations from JA 07 to JA 84. The first blueback, a gravid male, was taken in Yarmouth Creek (Chickahominy drainage) on March 20 in fresh water (salinity 0.15 0/00) at 9.0° C. The next blueback was captured on April 3 (water temperature 15.1° C), but bluebacks did not consistently appear in gill net catches until mid-April when water temperatures in the tributaries ranged from 14.1 to 20.7° C. Bluebacks began spawning in late April and continued until the last of May during which time water temperatures ranged from 19.8 to 24.3° C. The greatest number per unit effort was taken from Diascund Creek in the Chickahominy River system and Gunns Run and Queens Creek emptying into the James River at JA 56. Only two adult fish were found in tributaries of the lower, brackish section of the river, and follow-up sampling indicated no evidence of spawning. Apparently some fish enter brackish tributaries but do not stay there to spawn.

American shad were caught at mainstream stations from JA 40 to JA 72 and in the Appomattox River. The first shad was taken

in the Appomattox River on April 3 (water temperature 13.9° C) and shad were caught consistently at various stations in the river until mid-May when water temperatures reached 19.6°C. Apparently most shad spawn in the mainstream between JA 53 and JA 60 and in the Appomattox River. These areas yielded the greatest concentrations of ripe and near-ripe fish.

Delineation of definite spawning areas of the hickory shad in the James River is precluded by the capture of only eight fish. A running ripe male was caught in the Appomattox River (13.5° C), and another in Herring Creek (20.7° C). The advanced development of the gonads of these fish indicates they were probably at the spawning area. The other fish of this species were taken at JA 40, 60, and 66 and were not ripe. Hickory shad have been observed spawning at the Fall Line in Richmond.

Nursery Areas

To determine the area of the James River serving as the nursery for the juvenile alosids, monthly trawl surveys were carried out, beginning in February 1969 for one year (this report covers results to September 1969). Areas serving as nurseries were identified by the presence of larval or juvenile fish. Juveniles were collected with beach seine, semi-balloon otter trawl, and Cobb midwater trawl. All alosids were counted and measured upon capture, and growth rates were plotted for shad, alewife, and blueback (Figure 9). During the period covered in this report 1189 samples were taken in the James River system, 558 in the mainstream and 631 in the tributaries. The increased effort in the tributaries was made possible by acquisition of a 5-foot midwater trawl developed primarily to investigate

the role of the tributaries as nursery areas. A shallow-draft boat was equipped with a winch and rigging to handle this trawl. Stations were sampled from JA 01 one mile upriver from the Hampton Roads Bridge-Tunnel, to JA 84, approximately one-half mile below Upper Municipal Terminal at Richmond; in addition to the mainstream stations, monthly trawl tows were also made in Turkey Island Oxbow (JA 67) and Jones Neck Oxbow (JA 71). Usually collections were made at each station at three depths: surface, midwater (Cobb trawl), and bottom (30-foot semi-balloon trawl). Surface tows sampled the water column from 0 to 10 feet, midwater sampled between 10 and 20 feet in the water column. Tables 13, 14, 15 give the longitudinal and vertical distribution of juveniles by number per 5-minute tow at each station by month during the period covered in this report.

From February through September, 261 trawl hauls captured a total of 54,509 juvenile alosids in the James River; 40,959 (76 %) were blueback, 9,239 (17 %) alewife, and 4,011 (7%) American shad.

During the period form February through May all alosids caught by trawling were yearling fish averaging in fork length 79.2 mm for blueback, 107.8 mm for alewife, and 113.5 mm for shad. Beginning in June all alosids taken by trawl were young-of-year. Yearlings were consistently more abundant on the bottom, while the young-of-year were more numerous near the surface. From February through May 0.2% of all juvenile alosids were caught at the surface, 2.8% at midwater (15') and 97% on bottom. The distribution from June through September was strikingly different with 82% taken on the surface, 13.6% at midwater and 4.4% on the bottom.

Table 13. Monthly Distribution of A. pseudoharengus in the James River in numbers of juveniles per 5 minute tow at each station.

		0	5	10	15	20	25	30	35	40	45	50	55	60	65	TIO	70	JNO	75	80	84	Total
June		0	0	0	0	0	0	0	1	5	10	69	0	1923	19	1467	2	9	6	0	1	3511
July		0	0	0	2	0	0	2	8	10	3	24	6	182	154	446	1	6	4	2	1	849
August		0	0	0	0	0	101	52	9	3	23	68	58	450	299	66	6	4	46	259	2	1446
August Flood		0	0	3	9	32	61	26	35	2	2	1	0	0	0	0	2	1	1	0	0	175
September					3	21	49	6	14	9	12	12	1	89	260	171	17	28	0	0	0	692
Total				3	14	53	211	86	68	32	55	210	65	3634	741	2906	29	52	59	261	4	
June	S	-	-	-	-	-	-	0	1	5	5	8	0	1815	5	1467	1	9	3	0	1	3320
	M	-	-	0	0	0	0	-	-	1	5	61	0	108	14	-	1	-	3	0	-	191
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0	-	0
July	S	0	0	0	2	0	0	0	0	0	1	2	1	114	151	445	1	4	2	2	1	726
	M	-	0	-	0	-	-	2	8	10	2	22	5	68	2	-	0	-	2	0	-	119
	B	0	0	0	0	0	0	0	0	-	0	0	-	0	1	1	0	2	0	0	-	4
August	S	0	0	0	0	0	5	6	6	2	17	16	50	353	288	51	3	4	46	259	2	1108
	M	-	-	-	-	-	91	46	3	0	5	52	8	97	6	-	3	-	-	-	-	311
	B	0	0	0	0	0	5	0	0	1	1	0	0	0	5	15	0	0	0	0	-	27
August Flood	S	0	0	3	9	32	45	23	31	1	1	1	0	0	0	0	2	1	1	0	0	150
	M	-	-	-	0	-	16	3	4	1	1	0	0	0	0	-	0	-	0	0	-	25
	B	-	0	-	0	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	-	0
September	S	0	0	0	0	0	2	6	8	3	5	8	0	69	230	163	9	27	0	0	0	530
	M	0	0	0	2	15	41	0	2	6	1	4	0	12	29	-	8	-	0	0	-	120
	B	0	0	0	1	6	6	0	4	0	6	0	1	8	1	8	0	1	0	0	-	42

Table 14. Monthly Distribution of A. aestivalis in the James River in numbers of juveniles per 5 minute tow at each station

		0	5	10	15	20	25	30	35	40	45	50	55	60	65	TIO	70	JNO	75	80	84	Total
June		0	0	0	0	0	0	0	4	1	490	316	1005	347	10	3022	14	33	1	-	0	5242
July		0	0	0	0	0	1	0	85	6	59	102	169	4773	1660	4883	23	63	64	5	2	11875
August		0	0	0	0	0	0	92	25	35	465	1403	1916	1685	3647	3855	100	25	302	104	0	13656
August Flood					7	111	805	2925	540	238	51	22	5	10	9	13	8	8	2	0	0	4787
September							10	6	394	16	105	302	285	2235	136	629	1690	542	26	6	4	6386
Total		0	0	0	7	111	816	3023	1050	297	1424	2307	3898	9228	5467	13958	1842	688	396	116	6	
June	S	-	-	-	-	-	-	0	4	1	488	283	242	325	6	3022	5	33	1	1	0	4410
	M	-	-	0	0	0	0	-	-	0	3	33	76	21	4		9			1	-	832
	B	0	0	0	0	0	0	0	0	0	0	0	3	1	0	-	0	-	0	0	-	4
July	S	0	0	0	0	0	0	0	16	6	16	45	98	4717	1626	4870	9	62	33	4	2	11504
	M	-	0	-	0	-	1	0	69	0	43	53	71	50	14	-	14	-	31	1	-	347
	B	0	0	0	0	0	0	0	0	-	0	4	-	6	0	13	0	1	0	0	-	24
August	S	0	0	0	0	0	0	11	18	32	432	1029	1866	229	2116	2081	51	25	302	104	0	8318
	M	-	-	-	-	-	0	17	7	3	33	374	50	1456	1531	-	44	-	-	-	-	3556
	B	0	0	0	0	0	0	1	0	0	0	0	0	0	2	1774	5	0	0	0	-	1782
August Flood	S	0	0	0	7	111	518	1634	249	80	26	14	1	7	7	1	26	7	0	0	0	2688
	M	-	-	-	0	-	297	1291	291	158	25	8	4	3	2	-	5	-	1	0	1	2085
	B	-	0	-	0	-	-	-	-	-	-	-	-	-	-	12	0	1	1	0	-	14
September	S	0	0	0	0	0	1	5	310	9	69	155	30	1969	128	603	1600	509	14	4	4	5410
	M	0	0	0	0	0	9	1	50	4	29	142	9	262	5	-	63	-	12	2	-	588
	B	0	0	0	0	0	0	0	34	3	7	5	246	4	3	26	27	33	0	0	-	388

Table 15. Monthly Distribution of A. sapidissima in the James River in numbers of juveniles per 5 minute tow at each station

		0	5	10	15	20	25	30	35	40	45	50	55	60	65	TIO	70	JNO	75	80	84	Total
June		0	0	0	0	0	0	0	0	1	0	9	20	75	13	1454	0					1572
July		0	0	0	0	0	0	2	2	1	1	5	11	71	50	114	31	8	4	4	0	305
August		0	0	0	0	0	1	194	10	2	12	25	308	272	266	18	6	1	5	8	0	1128
August Flood		0	0	0	1	3	13	9	26	7	10	0	0	0	2	0	4	1	1	0	0	77
September		0	0	0	0	0	2	19	3	3	0	0	3	21	98	10	2	12	5	0	0	178
Total					1	3	16	224	41	15	23	43	352	477	436	2345	43	22	15	12	0	
June	S	-	-	-	-	-	-	0	0	1	-	9	2	65	7	1454						1538
	M	-	-	0	0	0	0	-	-				18	9	5	-		-			-	33
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0	-	0
July	S	0	0	0	0	0	0	2	2	1	0	5	4	43	50	114	31	8	3	2	0	265
	M	-	0	-	0	-	-	0	0	0	1	0	7	25	0	-	1	-	1	2	-	37
	B	0	0	0	0	0	0	0	0	-	0	0	-	3	0	0	0	0	0	0	-	3
August	S	0	0	0	0	0	1	0	2	1	8	5	285	175	220	15	6	1	5	8	0	732
	M	-	-	-	-	-	0	190	7	1	4	20	23	96	45	-	0	-	-	-	-	386
	B	0	0	0	0	0	0	4	1	0	0	0	0	1	1	3	0	0	0	0	-	10
August Flood	S	0	0	0	1	3	10	3	24	5	6	0	0	0	2	0	3	0	0	0	0	57
	M	-	-	-	0	-	3	6	2	2	4	0	0	0	0	-	0	-	0	0	-	17
	B	-	0	-	0	-	-	-	-	-	-	-	-	-	-	0	1	1	1	0	-	3
September	S	0	0	0	0	0	1	19	2	1	0	0	1	19	83	7	1	11	3	0	0	148
	M	0	0	0	0	0	1	0	1	1	0	0	0	2	15	-	1	-	2	0	-	23
	B	0	0	0	0	0	0	0	0	1	0	0	2	0	0	3	0	1	0	0	-	7

In late August of 1969 the James River experienced a major flood, resulting from Hurricane Camille, which displaced juvenile alosids some 20 to 30 miles downstream. By mid-September the juveniles were generally relocated at the upstream stations, but were less numerous than before the flood. The downriver dislocation of the juveniles may have initiated a somewhat premature seaward migration, particularly with alewives and shad. Another possibility is that some of them sought refuge from the flood waters in the downriver tributaries, and simply stayed there until decreasing water temperatures in the fall prompted seaward migration. Immediately after the flood juveniles were numerous in most of the downriver tributaries; unfortunately the tributaries were not sampled prior to the flood. In 1970, part of our planned program will be to investigate the role of the tributaries within the nursery area in the James River.

Excluding the distribution data accumulated during August flood, monthly trawl cruises during June through September found juvenile river herring and shad distributed from JA 15 (mean salinity 15.84 0/00) to the upper limit of sampling at JA 84 (mean salinity 0.25 0/00). The eight-mile section of river from JA 60 to Turkey Island Oxbow (TIO) yielded 75% of all juveniles caught during the four month period; 72% of the blueback, 88% of the alewife, and 82% of the shad. More juveniles (19,196) were caught in Turkey Island Oxbow than any other single station. During the spring spawning period several adults, particularly alewife and shad, were collected from Turkey Island Oxbow and tributaries and many main stream tributaries adjacent to Turkey Island. In addition to proximity to spawning

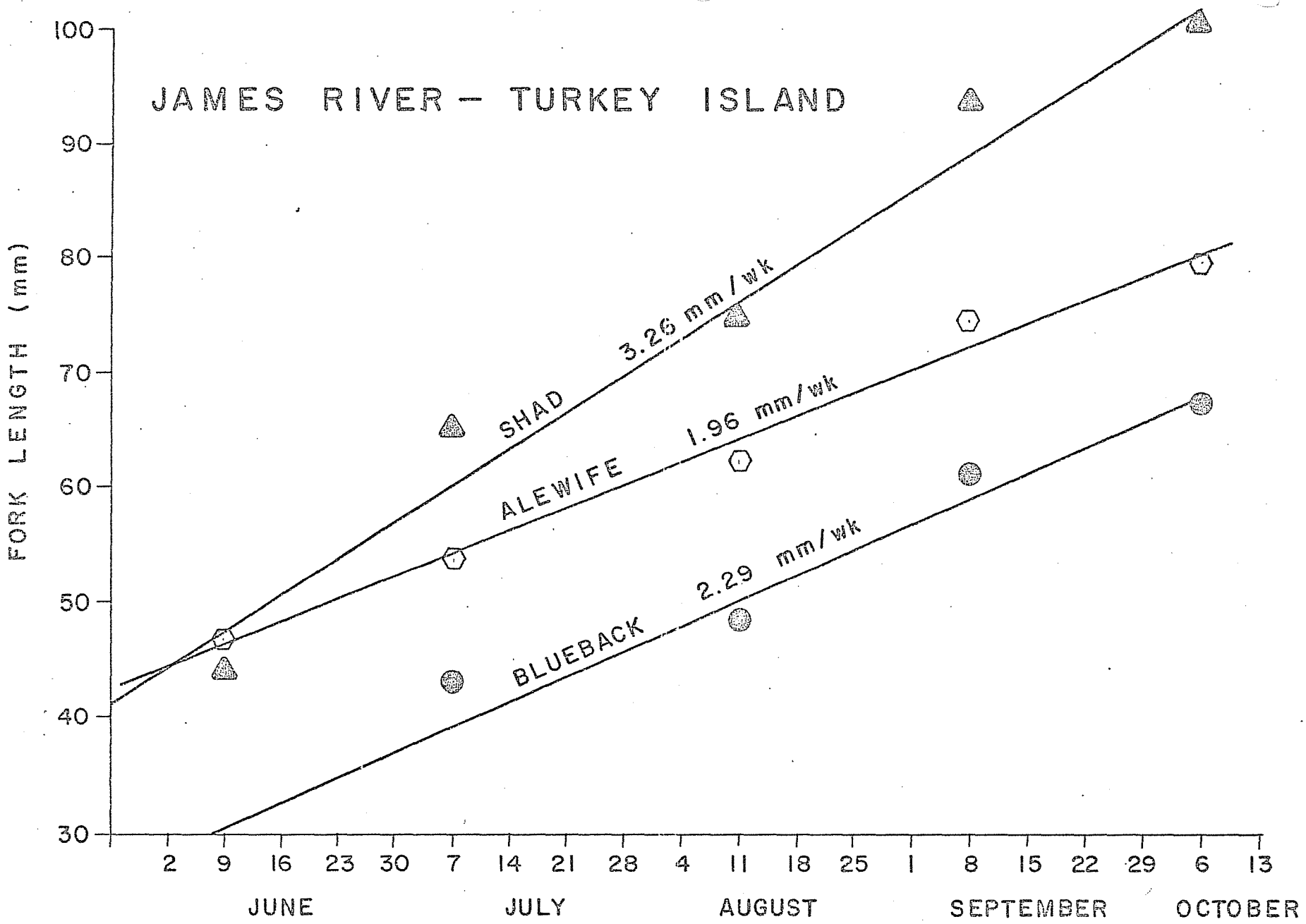

Fig. 12. Growth rates of juvenile alosids in Turkey Island Oxbow.

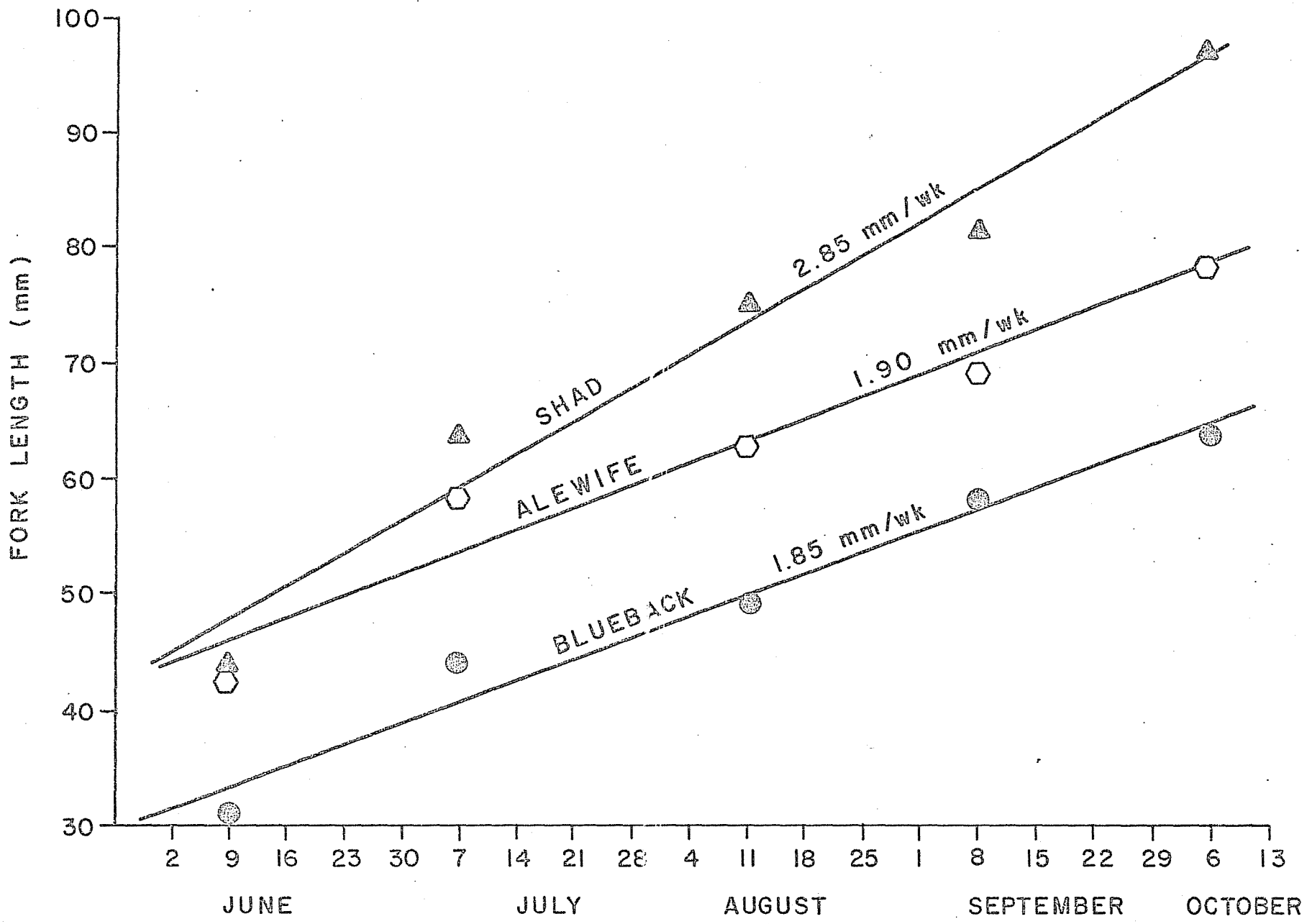

Fig. 13. Growth rates of juvenile alosids in the James River.

areas significant reason for juveniles being found in such abundance at Turkey Island Oxbow is indicated by nutrient studies conducted by the Ecology-Pollution Department at VIMS which show an area from JA 57 to JA68 (TIO is at JA 67) to be highly enriched. Chlorophyll "a" values were consistently higher in this area than in other sections of the river, especially during the period from June through September. The high productivity of the Turkey Island area is also reflected in the rapid growth of juveniles there (Figures 12 and 13). Bluebacks in Turkey Island Oxbow grew at an average weekly rate of 0.44 mm greater than those at other stations, with shad nearly matching this rate with a differential of 0.41 mm per week. Growth rates of young alewife in the oxbows were nearly identical with those elsewhere.

Physico-Chemical Features

The tidal portion of the James River extends from the fall line at Richmond 85 nautical miles to the Chesapeake Bay via the channel. An additional 17 miles of tidal water is contained in four oxbows formerly constituting the mainstream but now bypassed by dredged cuts. Of these Farrar's Island Oxbow is navigable through only part of its length and is utilized as a receiving stream and heat sink by the Virginia Electric and Power Company's Chesterfield power plant.

The salinity distribution in the James for the months of February through September 1969, is given in Table 16. Salt water intrusion varied from a minimum of 30 miles to a maximum of 45 miles during this period depending upon the discharge rate in the river. During the flood resulting from Hurricane Camille, salinity values of less than 1 ppt. were measured as far downstrean as JA 25. The average discharge rates at Richmond as reported by the Virginia

Table 16. Salinity Distribution - James River, 1969.
Salinities at 3m depth except as indicated

...cation	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
01	22.4	-	22.1b	21.1s	-	23.4	22.2	17.3c	21.4
05	22.3	-	20.5	21.9s	22.0	23.3	23.4	22.6	22.3
10	21.6	-	15.0	19.1s	18.6	20.4	19.9	19.0c	19.1
15	17.9	-	12.3	15.1s	14.8	17.8	18.0	14.6c	15.8
20	10.5	7.7b	5.2	8.9s	9.3	10.8	7.0	10.2c	8.7
25	7.6	2.6b	1.3	4.0s	6.5	7.8	2.6	3.5c	4.5
30	6.0	0.6b	0.7	3.6	5.2	5.3	0.7	0.7s	2.9
35	2.1	-	0.1	1.5	2.3	2.3	0.3	0.1s	1.3
40	3.4	0.0b	0.1	0.7	1.0	0.9	0.2	0.9s	0.9
	0.7	-	-	0.1	0.2	0.2	0.2	0.1s	0.2
50	0.7	-	-	0.1	0.1	0.1	0.2	0.1s	0.2
55	0.7	-	-	0.1	0.1	0.2	0.2	0.1s	0.2
60	0.6	-	-	0.1	0.1	0.2	0.2	0.1s	0.2
65	0.7	-	-	0.1	0.1	0.2	0.3	0.1s	0.2
OX	0.7	-	-	0.1	0.1	0.2	0.2	-	0.3
70	0.6	-	-	0.1	0.1	0.1	0.3	-	0.2
OX	0.7	-	-	0.1	0.1	0.1	0.2	-	0.3
75	0.6	-	-	0.2	0.0	0.1	0.2	-	0.2
80	0.6	-	-	0.1	0.0	0.1	0.2	-	0.4
84	0.6	-	-	0.1	0.0	0.1	0.2	-	0.2
. Discharge in cfs				3,394	3,255	4,567	6,670*		

p: flood
- bottom
- 2m depth
- surface

Division of Water Resources are also shown in Table 16. The maximum flood discharge of 225,000 cfs was recorded on August 22.

Mean water temperatures are shown in Figure 14 at 10 mile intervals. The lowest recorded temperature was 2.4° C at the river mouth February 19, 1969, and the highest temperature in the mainstream was 30.5° C at JA 60 July 16. On August 26, 4 days after the flood crest, the surface temperature in Farrar's Island Oxbow, 2.8 miles from the power plant, was 30.0° C compared with 27.9° C in Hatcher's Island Oxbow, 24.4° C in Jones Neck Oxbow and 23.7° C in Turkey Island Oxbow.

Although the upper tidal James River from Richmond to Hopewell is heavily polluted by domestic and industrial wastes, the lowest dissolved oxygen value determined from samples taken during the monthly trawl surveys was 1.6 mg/l in mid-August at station JA 50, 15 miles down river from City Point, Hopewell. Values below 2 mg/l were found in May at JA 70 and JN Oxbow, and in August at JA 50. Values of less than 25% saturation were found in May from JA 75 to JA 65 including Jones Neck OXbow, in June at JA 80, in July in Jones Neck Oxbow, and in August at JA 50 (Table 17).

The low dissolved oxygen values were found in periods of low flow and high water temperatures. The average discharge in May and June approached the 57 year average of 3200 cfs for the normally low flow months of June through November. July and August of 1969, months of normally high water temperatures, were above average in river flow; consequently critical dissolved oxygen values were seldom observed in the summer of 1969. Dissolved oxygen was present in less than 50% saturation from Richmond to JA 30 in

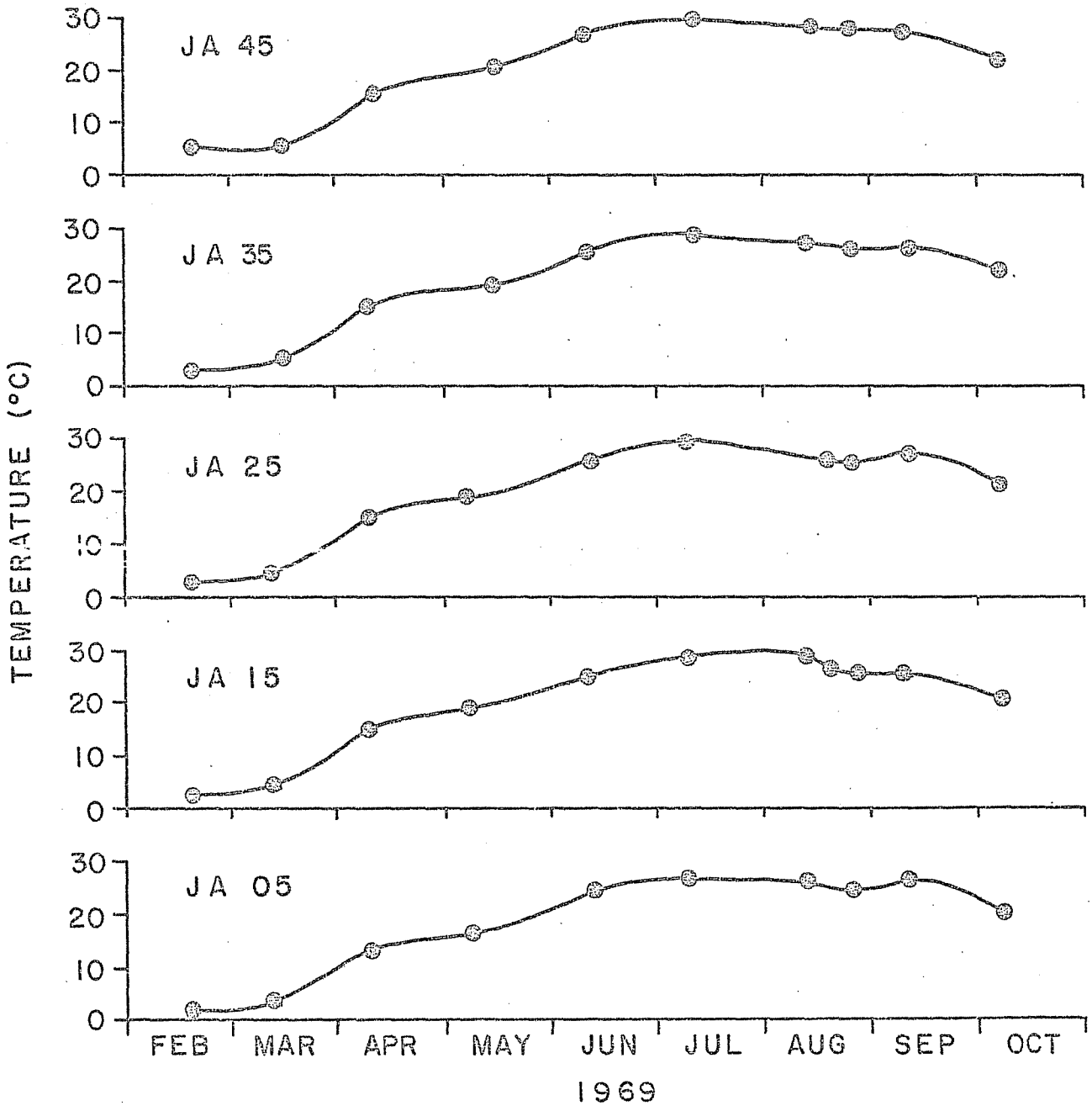

Fig. 14. Surface Water Temperatures - 1969 James River.

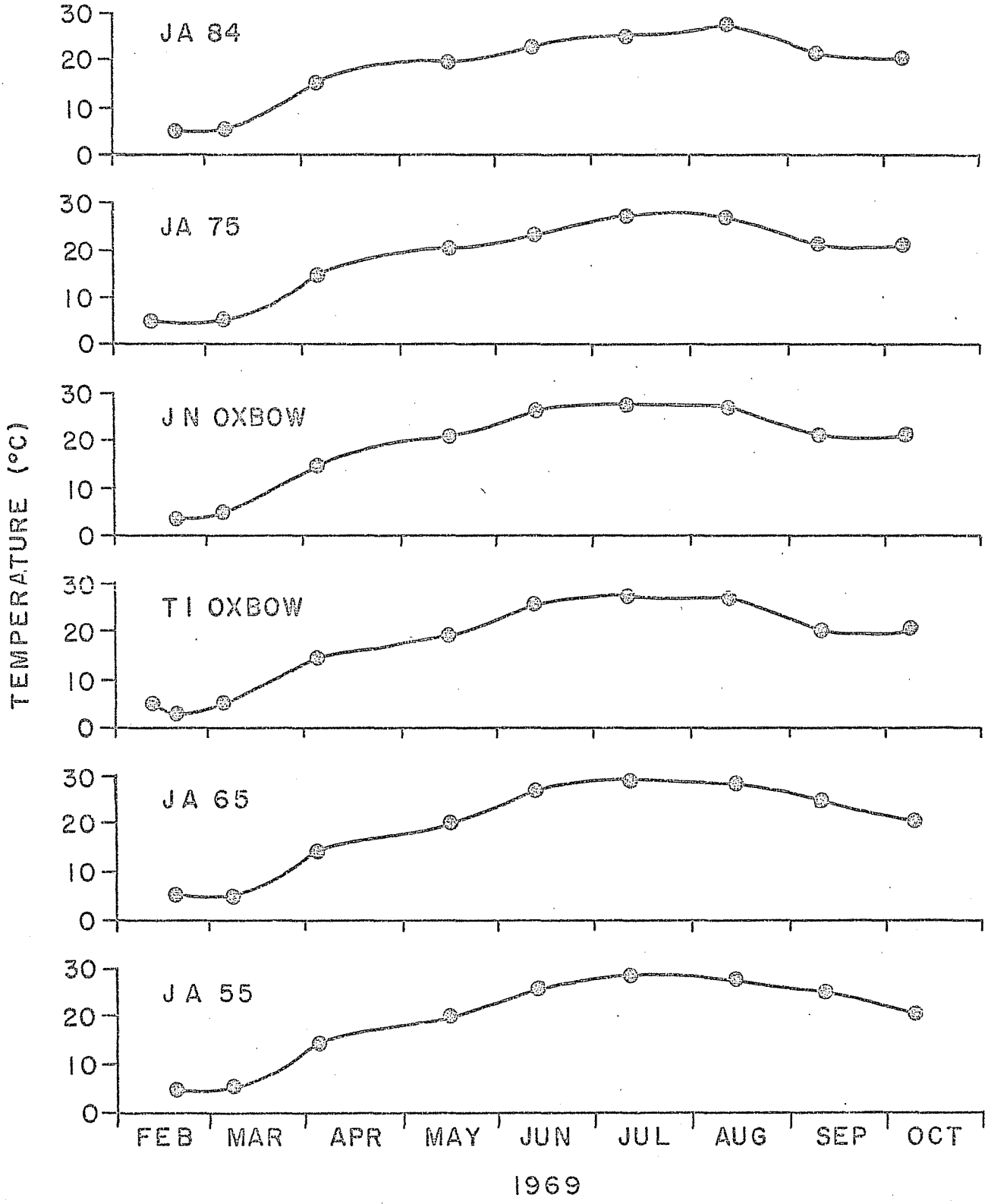
JA 84
JA 75
J N OXBOW
T I OXBOW
JA 65
J A 55
30
20
10
0
TEMPERATURE (°C)
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
1969

Fig. 14. (cont'd.)

Table 17. Dissolved Oxygen expressed as percentage of saturation at the surface (S) and bottom (B) in the James River.

	Feb. 6-19		May 5-14		June 4-11		July 7-9		Aug. 11-14		Sept. 8-28	
	S	B	S	B	S	B	S	B	S	B	S	B
JA 00	129	95					93	78			92	60
JA 05	96	99					98	81			56	38
JA 10	98	91					75	71			81	40
JA 15	96	96					76	69			80	38
JA 20	96	94					82	70			78	32
JA 25	93	105					91	82			78	60
JA 30	90	91	48	46			84	80			85	89
JA 35	75	79	46	47			86	83	67	64	81	84
JA 40	78	74	46	45			82	81	58	66	70	81
JA 45	73	73	30	32			61	57	25	27	57	54
JA 50	73	73	30	27			39	30	24	20	41	42
JA 55	75	76	34	31			62	37	33	36	45	47
JA 60	67	75	30	26			59	44	46	40	42	44
JA 65	77	73	26	23	79	79	71	70	58	57	38	47
JI OX	84	89	27	26	32	28	48	64	59	50		
JA 70	90	89	20	22	43	47	29	29	53	55		
JN OX	82	83	22	22	35	79	23	32	53	52		
A 75	92	93	28	24	44	54	63	62	64	62		
JA 80	117	90	27	30	38	21	77	77	66	84		
JA 84	98	94	36	38	86	84	82	83	96	95		

May; in the reach from JA 80 to Turkey Island in June; from Jones Neck to Turkey Island and from JA 60 to JA 50 in July; from JA 60 to JA 45 in August; and from JA 65 to JA 50 in September. Depressed oxygen values near the bottom of the water column in saline water from JA 20 to JA 05 in September possibly resulted from the decomposition of large quantities of organic matter transported downstream during the flood.